Using System Archetypes to identify safety behaviours within the Malaysian construction industry

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ABSTRACT

The construction industry, particularly in Asia, experiences disproportionately high numbers of occupational injuries and fatalities. Malaysian construction fatality rates are more than double those in developed nations. Systems thinking has previously been used to identify 'archetypal' casual structures underpinning safety-related construction behaviours via a Grounded Theory analysis of interview data from construction safety professionals in New Zealand (Guo et al. 2015). This paper partially replicates the method of this prior work within a different cultural context in order to further validate the method and evaluate the extent to which the previously identified structures are indeed archetypal. Seven interviews were conducted with Malaysian construction industry professionals. Three potential archetypal structures were identified concerning: (1) effects of a migrant workforce, (2) corporate accountability and profit driven business culture, and (3) issues in the regulatory system. The structure of behavioural systems in Malaysian construction is depicted providing a view into the failings of construction safety management systems and the interventions to address them. Contractors' drive for profit was determined as a primary contributing factor in most causal relationships identified. The method is shown to be useful and evidence produced to suggest at least one of the previously proposed causal structures is archetypal.

KEYWORDS: Construction safety, systems thinking, archetypes, Malaysian construction, systems dynamics

1. Introduction

Construction is a hazardous sector (Im et al., 2009; Razak, Ibrahim, Roy, Ahmed, & Imtiaz, 2010; Ringen, Seegal, & Englund, 1995). It experiences a disproportionately large number of injuries and fatalities for the number of people employed, compared to other industries (Chong & Low, 2014; Ringen et al., 1995; Waehrer, Dong, Miller, Haile, & Men, 2007). Fatal occupational accidents occur much more regularly in Asian countries than more established market economies of the European Union, North America and Australasia (Hämäläinen, Takala, & Saarela, 2006; Takala, 1999). Two economically and culturally different countries are central to the study described here, Malaysia and New Zealand. Comparing these two in terms of construction industry fatalities shows Malaysia recorded a rate 2.6 times higher than that of New Zealand over the period between 2013 and 2017 (see Table 1).

TABLE 1

The danger of construction can be attributed to a variety of factors. For example, the transient nature of the workforce (often referred to as 'mobility') results in low skill workers being constantly introduced to the industry and moving from project to project (Fang, Chen, & Wong, 2006; Guo, Yiu, & González, 2015; Lunt, Bates, Bennett, & Hopkinson, 2008; Sawacha, Naoum, & Fong, 1999). This can inhibit the cultivation of a strong safety culture. Establishing a strong, positive safety culture can be a crucial tool to assist organisations with improving safety performance (Choudhry, Fang, & Mohamed, 2007; Cooper, 2000). Cooper (2000) defines safety culture as the "observable degree of effort by which all organizational members directs their attention and actions toward improving safety on a daily basis". It has become a staple in the vocabulary of those concerned with construction related accidents, due to its ability to encompass behavioural, psychological, and management factors into a single management designation (Choudhry et al., 2007).

This mobility is compounded by issues arising from “decentralization” (Fang et al., 2006) in the construction industry. This is a concept that suggests as employees are often distributed and separated by site, they are dissociated from the regulation and planning that governs them, which, in combination with the often complex and novel working conditions present, leads to workers having to make autonomous decisions (Fang et al., 2006; P. T. Mitropoulos & Cupido, 2009; Sawacha et al., 1999). Letting workers make autonomous decisions assumes that they are properly trained in their field and are skilled enough to make such choices - which is not always the case. This combination of work conditions and pressures, as well as construction crews themselves determining how work is structured and coordinated, increases the likelihood of errors arising (P. T. Mitropoulos & Cupido, 2009; Sawacha et al., 1999). Thus, due to the nature of construction, it is difficult for organisations to tackle safety with an organisational, systemic approach (Guo et al., 2015; Lunt et al., 2008).

This paper explores the use of networks of cause and effect to describe construction safety behaviour, evaluating and developing the work of Guo et al. (2015) to determine whether these structures are archetypal across cultural differences.

2. Background

System Archetypes are the name given to a set of generic structures of cause and effect feedback loops popularised by Senge (1990). They can be used to explain and describe the common behaviours of a system (which in the context of this paper could include a construction site, company, or whole industry). Senge argues that these cause and effect feedback structures can be so influential on a system's behaviour that almost any human actor placed in a system where those structures are present will produce the same results.

Guo et al.'s (2015) research led to the fabrication of 8 System Archetypes specific to safety-related behaviours observed in the construction sector. These were based on data collected from construction professionals in New Zealand, blended with the 8 general System Archetypes created by Senge (1990). However, Guo et al. recognised that for these structures to be truly archetypal, their research must be consolidated through "future research in different cultural settings" (Guo et al., 2015). This paper attempts to validate and develop their prior research using a similar methodology within the Malaysian construction industry.

2.1 Malaysian & New Zealand culture

Before proceeding it is necessary to establish whether New Zealand and Malaysia do indeed provide different cultural settings. Malaysia's national culture features a melting pot of different ethnicities and religions, contributing to a unique and diverse culture (Ahmad, 1997). Malaysian culture can be constructed from its main constituent cultures - Malay, Chinese, and Indian. Religion is an acknowledged descriptive aspect of culture (Herskovits, 1949), therefore culture can be further derived from the main religious ideologies practiced by these groups. Table 2 shows the contrast between the religions practiced by Malaysia and New Zealand. While there are many alternative dimensions on which to differentiate cultures, based on the aforementioned use of practiced religion as a proxy gauge of culture, it can be justified for the intentions of this paper that New Zealand and Malaysian cultures are significantly different.

TABLE 2

A study by Goodwin and Goodwin (1999) invokes a framework devised by Hofstede (1980, 1983) to compare the cultures of New Zealand and Malaysia. They note the difficulty in assessing Malaysia's culture due to its diverse ethnic mix. Hofstede's framework has five cultural dimensions: (i) expectations of equality and willingness to challenge superiors; (ii) comfort with uncertainty and adherence to rules; (iii) individualism vs collectivism; (iv) aggressive vs supportive behaviour, and; (v) long term vs short term thinking. Hofstede found that Malaysia has considerably lower expectations of equality and willingness to challenge superiors when compared to New Zealand, a slightly higher tendency towards uncertainty avoidance and a marginally more collectivist and supportive society. Malaysia's long-term vs short-term thinking was not included in the study. Goodwin and Goodwin's study found that there were differences in responses to ethical issues among students between New Zealand and Malaysia

2.2 The Malaysian construction industry

Malaysia has a diverse construction workforce, being the most reliant on foreign workers in Asia (Pillai, 1999). 15.6% of the total Malaysian labour force is made up of immigrant workers (Department of Statistics Malaysia, 2017b). These workers contribute to 69% of the labour used in the construction industry (Abdul-Rahman, Wang, Wood, & Low, 2012). This is a considerably higher proportion of foreign workers than the approx. 11% active in UK construction (Office for National Statistics, 2017) and approx.19% in New Zealand (McLeod & Mare, 2013). This 69% is suspected to be much higher due to construction industry growth in Malaysia, and the undocumented arrival of at least one million illegal immigrants (Abdul-Rahman et al., 2012; Garcés-Mascareñas, 2010; Khan, Liew, & Ghazali, 2014; Salleh et al., 2014). The majority of immigrants (62%) are Indonesian (Salleh et al., 2014).

The presence of a vast foreign workforce presents a set of unique problems. These include, but are not limited to: the use of unskilled labour, repression of wages for local workers, commonplace practice of illegal activities, communication issues, and social problems (Abdul-Rahman et al., 2012).

2.3 The need and use of Safety Management Systems

The need to effectively manage construction safety is imperative due to the potential impact on human life. For some, keeping workers safe is as much about the economic impacts associated with the increasing costs of medical treatment, as it is the moral responsibility and duty of care placed on them (Hinze, Pedersen, & Fredley, 1998). Frequent and grave accidents can also have a serious impact on a construction company's operations, thus again it becomes economic as well as ethical to manage safety properly (Wilson & Koehn, 2000).

Accidents are controlled using safety management systems which are implemented through "policies, plans, procedures and processes" (Wachter & Yorio, 2014). Examples of these practices include, but are not limited to: guidelines, instructions, rules, safety toolbox talks, safety training, hazard management, safety inspections, devolving power to safety officers, daily communication between supervisors and workers regarding safety, declaring safety a priority, greater engagement from senior management in safety, and thorough accident investigation procedures (Guo et al., 2015; Vinodkumar & Bhasi, 2010). Koh and Rowlinson (2012) argue that these control-based practices are inadequate as they rely on error prevention and normative compliance. Furthermore, they suggest that focus on procedure compliance is at the expense of understanding the system holistically; such processes omit or overlook the key dynamic interactions between workers and their tasks in a wider context.

2.4 Systems Thinking in safety

Systems thinking is the general name given to an approach for managing problem situations that is different from, but complementary to the dominant approach. There are many definitions and explanations of what constitutes systems thinking, but they are all similar in essence. Von Bertalanffy (1968, p18) described the rise of the approach as a reaction to problems that were not suited to classical analysis. He noted that the more traditional approaches required the interactions between parts to be negligible and the relations between the parts to be linear. Modern complex systems did not fit these requirements. Thus, methods which broke entities or issues into their simpler parts in order to study them in relative isolation under the assumption an understating of the whole could be extrapolated from this, were not suitable for these complex issues (Ackoff, 1979, 2001). The Royal Academy of Engineering explains: “A system is a set of parts which, when combined, have qualities that are not present in any of the parts themselves. Those qualities are the emergent properties of the system” (The Royal Academy of Engineering 2007). Systems thinking, embodied in various tools and methods, is therefore an approach for thinking about complex entities and issues as if they are a single intricate system with associated interconnections, emergent properties and non-linear behaviours.

Early accident causation theory developed by Heinrich (1931) through his ‘domino’ theory suggests accidents are linear sequences of discrete actions, one causing the next, and that most accidents are rooted in human error. Reason (1997) significantly advanced the dominant model of accident causation to better encompass organisational accidents, through his ‘Swiss Cheese Model’ (SCM). The SCM improved on previous developments as it took into account the effects of holistic factors in a larger system as well as including the idea of organisational defence layers (Reason, 1997). The model imagined defence layers as barriers between loss-causing hazards, with ‘holes’ in the defences allowing for accidents to occur. The SCM included the consideration of these holes forming due to “active failures” (mostly human factors) and “latent conditions” (mostly organisational factors). This more advanced model is limited, as pointed out by Reason himself, in that it is not sufficiently dynamic (Reason, 1997). The model is better represented by moving defence layers, which change on local conditions, and holes constantly changing in size - representing the ever-changing risks and contributing factors to accidents.

Leveson (2011) suggested that such models are limited by their linear nature and presumption of a “root cause”. The inadequacy of assuming a root causes for an accident is that the choice of an “initial event” is subjective and thus a human decision, deeming activities preceding the “initial event” as irrelevant, has to be made (Leveson, 2011). Leveson also states that as real-life systems are constantly changing, linear models are not suitable as they have no provision for dynamic changes – they are not capable of capturing the complex nonlinear interactions between components in advanced socio-technical systems (Qureshi, 2007). For example, a supervisor instructing a worker to perform a task, then reviewing the progress of the task so that they can further instruct the worker creates a simple feedback loop that would not be adequately captured by these linear cause and effect models.

Systemic accident analysis (SAA) arose from these acknowledged shortfalls in the form of various systems analysis methods. Examples such as Systems Theoretic Accident Modelling and Processes (STAMP) (Leveson, 2011), Functional Resonance Analysis Method (FRAM) (Hollnagel & Goteman, 2004) and Accimapping (Rasmussen, 1997) have been said to avoid some of the limitations of these more traditional approaches (Underwood & Waterson, 2013). Crucially, SAA views accidents as an “emergent phenomena”, resultant of the complex interaction of systems components (Qureshi, 2007), thus understanding the dynamic interacting nature of factors within these incidents is critical.

STAMP is a control based theory that examines interactions between system components and views accidents as a result of inadequate control of these components

(Leveson, 2011). FRAM constructs a network of interrelating subsystems, with the behaviour of any one system component able to 'resonate' with that of others. Such resonance within components can result in dramatic system-level variation that pushes it out of control and to the point where an accident develops (Hollnagel, 2012). Accimap is a model that links failures across six socio-technical system levels (Salmon, Cornelissen, & Trotter, 2012), based on Rasmussen's socio-technical framework (Rasmussen, 1997). A cause-consequence chart is used to analyse cause events and link different factors across the various system levels (Qureshi, 2007). While these SAA methods are widely used in accident analysis (specifically STAMP and Accimap) (Salmon et al., 2012), they are considered as "resource intensive" as well as requiring "considerable amounts of domain and theoretical knowledge to apply" (Underwood & Waterson, 2013).

System dynamics was first pioneered by Forrester (Forrester, 1961) and was developed into a methodology for understanding "the structure and dynamics of complex systems" (Sterman, 2000). It embodies, and is to some synonymous with, systems thinking. The notion that systems thinking can be used to interpret intricate systems was echoed by Checkland (1981), who stated that systems thinking was "the use of a particular set of ideas, systems ideas, in trying to understand the world's complexity" (Checkland, 1981). Furthermore, system dynamics related methods – namely causal loop diagrams (see Figure 1a and Figure 1b) – may be better suited for the problems associated with traditional accident models as they emphasise the circular nature of complex systems - there is "no difference between cause and effect" (Goh, Brown, & Spickett, 2010). Causal loop diagrams can be used to create generic and frequently occurring system structures to describe common behaviours, called system archetypes, which are useful to identify points of leverage for change (Goh et al., 2010). These system archetypes can be viewed as "classifying structures responsible for generic patterns of behaviour over time" (E F Wolstenholme, 2003).

Systems thinking is suitable to understand the complexity (Checkland, 1981; Maani & Maharaj, 2004; Sterman, 2000) presented by construction accidents while system archetypes provide a concise way to visualise the complexity (Goh et al., 2010).

2.5 Study aims

As outlined in the previous section, the of use systems thinking in relation to safety is an effective way to conceptualise the complex issues present. It also provides a platform from which further safety improvements in the construction sector can be made (P. Mitropoulos, Abdelhamid, & Howell, 2005). Guo et al. (2015) asserted the pertinent point of needing to fully understand the interdependence of system factors, through the exploration of the linking behavioural system components that make them up.

Guo et al.'s (2015) research consisted of the creation of 8 'system archetypes' describing behaviour patterns characteristic of construction safety. Following the dictionary definition of an archetype being "something that is considered to be a perfect or typical example of a particular kind of person or thing, because it has all their most important characteristics" (Collins English Dictionary, 2018), it is inferred that the system archetypes proposed by Guo et al. (2015) should be applicable in any context. Guo et al. (2015) recognised the limitations of claiming to have identified archetypes, in that future research would be needed to establish their presence in "different cultural settings" for this to truly be the case. Thus, the aims of this study therefore are:

1. Establish the main factor or factors that contribute to construction accidents in Malaysia.
2. Evaluate and validate the grounded theory method devised by Guo et al. by utilising it in a new context.

3. By applying the method, independently develop and test potential archetypes present in the 'different cultural context' of the Malaysian construction industry. Doing so will potentially identify new archetypes, as well confirm whether Guo et al.'s models are truly archetypal.

3. Method

3.1 Creating construction safety archetypes

System archetypes can be represented through causal feedback loops. These are visual representations of the causal influences between contributing factors. The causal influences are represented by arrows between named variables. The arrows between the variables in feedback loops are marked either positive ('+') or negative ('-'). A positive arrow (positive polarity) means that the linked variables change in the same direction (e.g. if the parent variable decreases, the child variable will also decrease or if the parent variable were to increase, it would cause the child variable to increase). A negative arrow (negative polarity) describes a relationship between variables such that they are opposed (e.g. if the parent variable increases, the child variable will decrease and vice-versa). These two types of causal connection can combine to form two types of feedback loop representing either reinforcing or balancing relationships. Reinforcing loops (Figure 1a) act to exponentially increase (for an ascending trend) or decrease (for a descending trend) the effects of a phenomenon, with the rate of increase also inflating exponentially. Balancing loops (Figure 1b) act to close the gap between the current state and the desired state via some process or action (Guo et al., 2015), resisting change and attempting to maintain the status quo.

FIGURES 1a & 1b

Senge (1990) used this modelling approach to represent archetypal causal structures that underpin organisational issues, subsequently reinterpreted and developed by Marais et al (2006) into system safety-specific archetypes. Such system archetypes are fundamental to system dynamics modelling (Eric F. Wolstenholme, 2004). Construction safety archetypes then are simply system safety archetypes applied in the context of construction. They are intended to describe the causal structures that result in individual safety issues, rather than the whole system.

The first step in developing such representation involves the identification of the themes relating to an issue; the key variables associated with each theme or problem are also established (Guo et al., 2015). The second step requires the generalisation of these variables such that they are no longer event-specific, instead describing a generic pattern of behaviour, by exploring their causal affiliation with each other (Guo et al., 2015).

3.2 Grounded Theory for data collection

Grounded Theory, conceived by Glaser and Strauss (1967), is a methodology for creating theory that is “grounded in data systematically gathered and analysed” (Strauss & Corbin, 1994). As part of the process, Grounded Theory stipulates an analysis of constant comparison of data sources and of theory to data in order to identify emergent concepts (Glaser & Strauss, 1967). Thus, based on Grounded Theory, concurrent data collection, data analysis, archetype development, and constant comparison of data and models is performed. The data, in this case from interviews, is analysed and progressively abstracted such that it is described in terms of higher-order categories. The process as applied here is described in the subsequent sections.

3.3 Interview structure, sample strategy, and sample participants

Seven semi-structured interviews were conducted (i.e. there was a predefined set of questions, but participants were able to deviate from those and talk freely). Semi-structured interviews are "particularly effective" as a method of gathering data when developing causal diagrams (Sterman, 2000). Interviews focused on identifying the main safety themes through broad questions, spanning a multitude of topics. When a new theme revealed itself, further questions were directed on that specific line of thought. Due to the concurrent nature of data collection and analysis when utilising Grounded Theory, pointed questions were formulated between interviews, based on previous respondents, about specific safety topics. These questions were then asked to subsequent interviewees after they had referenced the relevant topic.

The precedent in Grounded Theory sampling is to employ sampling techniques sequentially (known as directed sampling) as data is collected and the theoretical model becomes focused (Bryant, Charmaz, & EDITORS, 2010). The techniques that are typically employed are (sequentially): convenience sampling, purposeful sampling, and theoretical sampling (Bryant et al., 2010). However, due to the time constraints of this study, only convenience sampling was carried out. This meant that participants were selected on the basis of accessibility, but did provide a large wealth of knowledge based on their considerable collective experience. Bryant et al. (2010) state the necessity of having "excellent participants to obtain excellent data". An excellent participant must: have experience of the phenomena under study, be willing to participate, give enough time to fully explain their experience, and be articulate and reflective (Bryant et al., 2010). The participants of this study fulfil those criteria. All participants were fluent in English, and willingly volunteered at least 30 minutes of their time (mean interview length: 45 minutes). Only one interview was not conducted face-to-face, this interview was conducted via Skype.

TABLE 3

3.4 Data analysis – Inductive System Diagrams

Inductive system diagram (ISD) methodology is one in which causal loop diagrams can be constructed through concept development of field data (Burchill & Fine, 1997). It utilises the grounded theory method to develop key variables that are closely linked to the data. Following this, the ISD methodology allows for these key variables to be causally linked via causal loop diagrams (Burchill & Fine, 1997). Thus, the causal loop diagrams (and resulting archetypes) are markedly ‘grounded’ in the data collected, lending to their validity. The development process of ISD methodology, adapted for the creation of a system archetype, is outlined in Figure 2.

3.5 Coding techniques

The standard grounded theory method for processing interview data was followed. This consisted of three ‘coding’ stages. The first was ‘open coding’, in which interview transcriptions were processed line-by-line, tagging data as ‘nodes’. Nodes can be thought of as folders representing an event, theme, or behaviour, which were filled with quotes taken from the raw data. These quotes are ‘coded’ under a specific node. Nodes describing similar events, variables, or topics were then grouped to form key themes – this allowed for the main safety themes to be identified. As this process was carried out, memos were taken as insight into the topic was gained and new theories began to formulate.

Upon the initial identification of a safety theme the second stage - ‘selective coding’ - was performed. Interview data was analysed by studying the events and ideas mentioned by participants to understand the behaviour patterns that they were speaking about, and determine under which themes these behaviours occur. This also allowed the determination of causal relationships between variables by utilising an adjacency matrix, which explored the affiliation between variables and whether the effect one had on another was positive or negative. Based on these causal links, word-arrow diagrams and self-contained causal loops were created.

‘Theoretical coding’ is the final stage of the process. Theoretical coding allowed for the fabrication of safety archetypes by consolidating the feedback loops created in selective coding. Related feedback loops were gathered under a single safety theme, creating a generic causal loop describing a set of patterns of behaviour – a safety archetype. The safety archetypes were validated against the collected data through constant comparison. All coding was performed using the software package NVIVO, developed for such analysis.

FIGURE 2

3.6 Establishing causal relationships from data

Exemplification of the process carried out in creating causal loop diagrams from interview data is outlined in Table 4. Open coding was used to tag the quotes shown under various themes (quotes can be tagged under more than one theme). Selective coding then allowed for the causal relationship between these themes to be explored, and the creation of causal links following that.

TABLE 4

Selective coding is used to combine the causal links shown in Table 4 to form a causal loop, as seen in Figure 3. Multiple feedback loops like this are then integrated together to create a system archetype by utilising theoretical coding. The quotes shown in Table 4 did not all come from the same source, highlighting the complex nature of construction behaviour and the lack of holistic knowledge possessed by members in the system. Causal arrows bisected by two parallel lines show a relationship that has a delay.

FIGURE 3

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4. Results

The interviews and open coding processes revealed a multitude of behaviours, which were grouped into nodes, safety themes, and then eventually combined to form safety archetypes as shown in Table 5.

TABLE 5

Each of the archetypes mentioned above will be explored in-depth, and leverage points (places to intervene in the system to counter unwanted behaviour) identified. Quotes from interviewees are included in italics.

4.1 Effects of a migrant workforce

Figure 4 shows a construction safety archetype relating to the workforce employed in Malaysian construction. A main safety theme of this archetype is the inadequacy of the workforce (S2); generally speaking, workers struggle to safely carry out a variety of construction activities. Another contributing factor is the unique communication challenges introduced by the use of a foreign workforce.

FIGURE 4

The prevalence of a foreign workforce is the consequence of various factors, including a shortage of local labour (Salleh et al., 2014) and the perception among Malaysians of construction industry being "dirty, difficult and dangerous" (Wong & Yazdanifard, 2015). However, labourers in this workforce are often untrained, as multiple interviewees echoed the sentiment of the following quote: "*A general worker on a construction site – they have no training"*. The 'communication issues in training' (R3) reinforcing loop has a direct effect on the 'unforeseen impacts of communication issues' (R4) reinforcing loop. Due to the communication issues presented by a foreign workforce, it is significantly harder to train them. This has a reinforcing effect as training would reduce the communication problems experienced. Many interviewees noted both the contractor's and client's overriding drive for profit - "*The majority of contractors within Malaysia ... they don't really care about the workers, it's about turnover profit and margins"*. This means that training is often ignored as it is perceived cheaper to continuously hire new workers as compared to training the whole workforce. However, this perception is incorrect as noted by an interviewee: "*training people to do the job means that they will do the job more safely and more quickly"*. This is depicted by the 'creation of an unskilled workforce' (R2) loop; untrained staff are more likely to be involved in accidents, after which they are replaced by new, similarly unskilled workers – perpetuating the cycle. The 'disregard for safety procedure' (R1) reinforcing loop shows a common vicious cycle that is cultivated in Malaysian construction. Schedule delays are inevitably incurred when accidents happen, resulting in slowed progress. The stagnation of production progress generates an increased cost to the contractor which, as previously discussed, is the antithesis to their project goal - make the most money possible. This means that the production pressure on site is increased to try to make up for this lost time. Increased production pressure then often leads to safety practices being ignored in favour of quicker work, which inevitably results in more unsafe behaviours and accidents - "*[upon the occurrence of delays, site managers] scream at their workers, who are just general workers, and health and safety goes out the window"*.

Leverage points

Moving Malaysia away from an unskilled foreign workforce would help to alleviate a number of construction safety issues in the country. However, the problem of the migrant workforce is not one that can be solved quickly nor easily, and for broader national and industry factors may not even be feasible, thus it will be more suitable to focus on the training provided to these labourers. Providing translated training courses and general communications training for employees that are not proficient in the local language will reduce problems associated with work orders and skills training. This will also reduce the reliance on a lingua franca with which verbal exchange is often misinterpreted. These steps will help to combat the negative behaviours of (R3) and (R4) reinforcing loops. Furthermore, the introduction of the balancing loop shown in Figure 5 will aid in alleviating the negative impacts of the reinforcing loop (R1). This loop could be practically implemented through the use of independent accident investigators.

FIGURE 5

4.2 Corporate accountability and profit driven business culture

Figure 6 shows a construction safety archetype describing behaviours exhibited by clients and contractors at the highest levels of Malaysian construction. One of the main themes of this archetype is that the foreign workforce is held with such little regard (S2) that it is almost viewed as dispensable. This means that even when accidents occur, they have little to no effect on contractors and clients.

FIGURE 6

The ‘person approach’ (B1) and ‘side effect of person approach’ (R1) are loops forming the “Blame on workers” archetype devised by Guo et al. (2015). Blaming workers reduces unsafe behaviours in the short term as it prevents minor transgressions and promotes procedural adherence. However, it also means more fundamental root causes and latent failures in the system go unidentified, as well as the procedures that prompted the transgressions – ultimately leading to the accident rate increasing. This archetype was determined to also occur in Malaysian construction but as can be seen, has an array of other feedback loops associated with it that are not present in Guo et al.'s research.

Furthermore, the tendency to blame workers is facilitated by the nature of the workforce; being made up of a migrant (often illegal) majority whom are offered little protection, particularly in the case of illegal workers – *"you often hear: "it was the dumb migrants fault, he didn't listen to me, and that's why this accident has happened". They've become the scapegoat, so there's no accountability.*" This leads into the 'value placed on workforce' (R2) reinforcing loop, in which limited accountability for accidents leads to the propensity of disregarding the safety of the foreign workforce. Interview data has indicated that foreign workers are already held in low regard by the contractors managing them – *"the Indonesians are just looked down on by everybody, same with the Bangladeshis, and same with the Pakistanis"* due to a myriad of culture factors (not featured in the archetype). This allows contractors to "*get away with accidents*", further lowering the value placed on the workforce. Intuitively this will influence the safety culture on site, which will affect the unsafe behaviours (and therefore accidents) that occur. The 'no training for workers' (R3) reinforcing loop shows the ease at which workers are terminated from Malaysian construction sites. Blaming workers for accidents increases the workforce turnover, which leads to a decrease in training as contractors don't believe in investing in a workforce that is quick to turnover – "the *turnover of staff reduces the willingness of contractors to train them – it's money down the drain".*

Leverage points

The common practice of blaming workers to reduce unsafe behaviours is clearly shown to be an ineffective safety management strategy; the loops (R1), (R2), and (R3) exhibit the ways in which this method is flawed. The simplest way to mitigate the negative impacts of these loops would be to eliminate the practice of blaming workers. This may be difficult to achieve due to construction management's reluctance to take ownership of accidents, as it is often easier and cheaper to terminate workers than to change working procedures and pay accident related fines. A change in regulation to allow more blame to be attributed to employing organisations, and heavier fines for infractions, would force a shift in the priorities held by construction managers. However, the problems associated with increased regulation (discussed in section 4.3) would have to be addressed.

4.3 Issues in the regulatory system

Figure 7 shows a construction safety archetype describing behaviour shown by Malaysian regulators and legislators. It is a modified version of Senge's "fixes that fail" archetype (Senge, 1990). The main theme of this archetype is the effect that enforcement has on safety performance. Analysis has suggested that enforcement of regulation is extremely poor in Malaysia, to the extent that contractors are comfortable in taking risk to avoid compliance with regulation in an attempt to save cost.

FIGURE 7

The 'penalisation inducing corruption' balancing loop (B3) demonstrates the ability of contractors/clients to avoid penalisation for noncompliance. This is enabled by the susceptibility of governmental agents to bribes and pressure from those in positions of power. "*Corruption is rife, and with that there's always the opportunity for something to be covered up or paid off"*. The construction industry has been identified as "the most corrupt sector in the world" (de Jong, Henry, & Stansbury, 2009); coupling this with Malaysia's reputation as a place rife with corruption (Alam Siddiquee, 2006), it is no surprise that corruption plays a large role in the Malaysian construction industry. The ability to avoid penalties is exploited by contractors as a way to evade costly compliance with regulation, as they know that they will not be penalised; *"Inspectors can be paid off if they do go and find something"*. This effect is carried into the 'effect of penalty on safety performance' (B2) balancing loop in which the avoidance of penalties induces a lower level of safety motivation and then performance - leading to more accidents. The 'performance reducing budget' (B1) balancing loop shows the delayed effect that safety performance has on budgeting. However, safety budget is often cut regardless of performance in an attempt to gain better profit margins – "*The contractor is always trying to look for ways to get higher profit, so they tend to cut, cut, cut safety budget."* – thus further impacting loop (B2). The 'safety performance' (B4) balancing loop shows the interconnected nature of performance and legislation. However, it must be noted that interviewees have detailed a marked inflexibility in government regarding the change of legislation, meaning that causal link between safety performance and legislation is weak – "*To actually make that [legislative] change would take an additional workload for somebody, are they willing to do that? From what I'm seeing, I don't see a willingness to change"*

Leverage points

The problem of legislative enforcement is one that was often mentioned by interviewees. As mentioned above, corruption is a large contributing factor to the lack of enforcement, however it is also affected by Malaysia's low governmental safety budget. In combination, these factors lead to a void in the enforcement of regulation, which is exploited by contractors to cut corners and utilise unsafe practices. To reduce these practices, loop (B3) needs to be opposed. This could be done through the introduction of policies that improve the transparency of construction transactions, particularly those paid to governmental agencies. Transparent actions would discourage government officials from accepting bribery payments as it would be easier to recognise corrupt activities.

5. Discussion

The three ‘construction safety archetypes’ detailed indicate patterns of behaviour, and the causal structures that produce them, at different hierarchical levels of the Malaysian construction industry.

The ‘effects of a migrant workforce’, ‘corporate accountability and profit driven business culture’, and ‘issues in the regulatory system’ archetypes show behaviour at site management, senior management, and governmental levels, respectively – each subsequent model serves to contextualise the previous one. These models describe the underlying behavioural structures found in Malaysia, indicating why certain construction behaviours are observed. Using systems thinking in this context allows for a greater understanding of the complex interconnectivity of management decisions and systems throughout hierarchical levels. Furthermore, these archetypes reveal causal relationships that are not obvious, allowing for an analysis of procedures and their effects that would have otherwise thought to be unrelated or counterintuitive. For example, the ‘effects of a migrant workforce’ archetype reveals an unlikely causal link in which the communication issues presented by a foreign workforce eventually leads to more foreign workers being hired (reinforcing loop ‘unforeseen impacts of communication issues’ (R4)). This example shows the strength of dynamic system analysis to fully identify all of a systems characteristics.

Rasmussen (1997) attributed certain major accidents to a "systematic migration of organisational behaviour toward accident under the influence of pressure toward cost-effectiveness in an aggressive, competitive environment". This was developed by Dekker (2016) who coined the concept of "drift into failure" in which organisations develop routines based on balancing productivity and safety, such that failures become a by-product of the system itself, rather than based on the decisions of individuals within the system (Dekker, 2016). These concepts are exhibited in the archetypes, particularly in the loops 'disregard for safety procedure' (R1), 'value placed on workforce' (R2), and 'penalisation inducing corruption' (B3) from each archetype respectively. These loops show routine behaviour that is not internally viewed as a contributing factor to unsafe behaviour, but undoubtedly has an effect.

The archetypes support Guo et al.'s (2015) assertions that safety management systems are unable to cope with the dynamic nature of the problem, and that safety considerations need to be integrated into all areas of a business. This is exemplified by the 'no training for workers' (R3) reinforcing loop in which there is no consideration of potential employees' skills when hiring new staff. However, in addressing study aim 3, Guo et al.'s (2015) archetypes have been proven to not be truly archetypal - they do not apply in all contexts. The archetype 'corporate accountability and profit driven business culture' demonstrates this. Whilst it shares the characteristics of the 'person approach' (B1) and 'side effect of person approach' (R1) loops with the identically named loops of Guo et al.'s (2015) "Blame on workers" archetype, the "Blame on workers" archetype excludes novel factors that occur outside of New Zealand. The presence of a lowly-valued migrant workforce presents a new dynamic effect for the variable 'blame on workers', in which workers are dispensable, thus raising issues of accountability that could only arise in such a context.

The grounded theory method proved to be effective in data collection and analysis. The utilisation of constant comparison allowed for theory to naturally emerge from the data and helped to direct questioning in further interviews, contributing to underdeveloped areas in the theory. Furthermore, grounded theory facilitated the creation of models that were directly related to the data collected, lending to their validity.

5.1 Malaysian Construction Behaviour

The client and contractors overriding drive for profit, through cost-cutting and progress motivated working procedures, was a principal factor that was unanimously mentioned by interviewees, but was not included explicitly in the archetypes themselves. It was excluded because it was intrinsic in the majority of variables, meaning that its inclusion would lead to its effect being double counted. The bulk of decisions taken by contractors are in regard to this sole interest, presenting the systemic, cultural problem that faces Malaysian construction. This behaviour is facilitated by a myriad of factors that occur in the Malaysian construction industry, including the ability to disregard the lives of foreign workers. A phrase that was often used by interviewees, in reference to labourers, was that of "life is cheap" - "*I think life is cheap because its immigrant labour – it's not as close to heart"*. Other factors that allow for the uncontentious ethos of profit driven business to thrive include, but are not limited to: the ability to corrupt government officials, the lack of enforcement of safety regulation, the availability of new migrant labourers, the lack of accountability for accidents at the management level, the weakness of safety regulation ("*[after a fatal accident] a RM50,000 fine. That's the price of a human here. A slap on the wrist and off you go.")*, high risk projects, and the use of unskilled labourers. A systemic moral permutation away from the industry's profit related objectives - into goals that have a recognition of the distinct social responsibilities the industry carries - is required to combat these issues.

These views must also be considered in the broader context of Malaysian culture, and in relation to the aims of this study, its comparison to New Zealand culture. Despite arguing that their cultures are different, an archetypal causal structure appears to have been identified that is present in both. This invites further consideration of the similarities and differences between their cultures. The detail of this ethnography is beyond the scope of the paper and indeed the expertise of its authors. It is therefore recommended as further work in addition to the discussions in following sub-section.

Nevertheless, it is interesting to briefly reflect on the differences in customs and other social behaviours that might warrant further investigation. Building on the point above, the statistical value of a life has been estimated through meta-study (Miller, 2000) at around \$1.6m (baselined to 1995 values) in New Zealand and \$600,000 in Malaysia. This is approximately \$2.7m and \$1m today. Worksafe, the New Zealand health and safety regulator recently fined a construction company NZ\$351,563 and NZ\$177,735 reparations. In total this is approximately RM1.4m or 28x the reported Malaysian fine.

5.2 Limitations and future research

This research has various limitations. Firstly, it was not feasible in thus study to carry out fully exploratory Grounded Theory. Data collection was limited to 7 interviews, less than the 20-30 participants recommended for Grounded Theory (Creswell, 2007), but not dissimilar to the number of participants used in other studies to produce safety-related causal loop models (e.g. the 7 interviwees of Kwesi-Buor, Menachof, & Talas, 2019) . Nor is it dissimilar to the number of participants in the more common group model building mode (e.g. the avergae of 7 particpants found in 15 qualitative and 19 quantitative studies by Rouwette, Vennix, & Mullekom, 2002). It does however mean that, similar to Guo et al. (2015), the ‘archetypes’ formulated in this paper may not be truly archetypal, as under the Grounded Theory approach data collection did not reach the point of saturation. Furthermore, no interviews were conducted with labourers themselves, only management staff. Whilst this gave perspective to behaviours beyond the ‘coalface’, it excludes the unique viewpoint of the migrant workforce. However, the paper aimed to independently develop casual loop models within a different cultural context in order to test whether Guo et.al.’s models were truly archetypal.   With the discovery of the of the ‘corporate accountability and profit driven business culture’ model the study is able to provide evidence to support their claim even with a smaller sample size. Hence the smaller number of participants is not a limitation on this aim. Nor is it a limitation on the ability to achieve the study’s humbler aim of verifying that the process can produce such structures. The limited number of participants *does* limit the ability to claim that the two additional structures are archetypal or even complete, however the fact that they emerged from interviews with the seven participants still suggests that other structures other causal loop structures and indeed other archetypes may exist. This would require a larger sample size.

It is stated that, for Grounded Theory, “the investigator needs to set aside […] theoretical ideas or notions so that the analytic, substantive theory can emerge” (Creswell, 2007). However, due to the nature of this study – developing Guo et al.’s (2015) theory – there may have been pre-existing theoretical notions based on the prior research influencing the method.

As the construction safety archetypes created in this paper are partially informed by Senge’s (1990) generic archetypes, criticism that is placed on Senge’s work can also be applicable to this research. It can be scrutinised according to analytical flaws; Senge relies on an inadequate definition of structure that “cannot explain the organizing practices and learning processes by which systems as feedback structures come into being and change” (Caldwell, 2012).

Future research within the Malaysian (and other nations) construction industry is needed to identify further construction safety archetypes. Furthermore, future research could focus on a different method of archetype construction/data collection, rather than the Grounded Theory based approach employed here.

5.3 Conclusions

This paper sought to identify the main factors affecting the safety of the construction industry in Malaysia. A series of interviews, and subsequent data analysis, illuminated the role of the migrant workforce, safety procedures, and governance of a profit driven industry. The Grounded Theory approach used by Guo et al. (2015) was partially validated in that it allowed for the underlying behavioural structures in the construction industry to be revealed and articulated as causal loops. It was also possible to identify corrective leverage points from these structures, establishing potential methods to reduce the unwanted behaviours displayed.

The 'corporate accountability and profit driven business culture' archetype revealed a similar structure to the "Blame on workers" archetype created by Guo et al., suggesting that this may indeed be archetypal. This study was also able contextualise the 'corporate accountability and profit driven business culture' archetype in the broader issues of the Malaysian construction industry.

The other structures identified in this study differed significantly from those created by Guo et al. This does not suggest that Guo et al.'s structures are not truly archetypal but indicates that additional construction safety archetypes may exist.

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Table 1: Fatality rates for different countries/regions (Takala 1999, Ministry of Business Innovation & Employment 2013, Department of Occupational Safety and Health 2017, Department of Statistics Malaysia 2017a, Worksafe New Zealand 2017)

Region	Annual average fatal occupational accident rate (per 100,000)	Country	Average construction fatality rate from 2013 to 2017 (per 100,000)
Asia and other islands	23.12	New Zealand	13.45
European Union	6.10	Malaysia	35.14

Table 2: Religions practiced in New Zealand and Malaysia (Department of Statistics Malaysia, 2011; Stats NZ, 2014)

	Religion practiced (% of population)					
Country	**Christianity**	**Islam**	**Buddhism**	**Hinduism**	**No Religion**	**Other**
New Zealand	48	1.2	1.5	2.1	41.9	5.3
Malaysia	9.2	61.3	19.8	6.3	0.7	3.4

Table 3: Participant occupation and experience

Participant number	Job title	Years of experience in Asia (in Malaysia)
1	HSE Risk Professional - Southeast Asia	15 (3)
2	Head of HSE	13 (6)
3	Senior Project Manager	19 (1.5)
4	HSE Manager	17 (14)
5	CEO (of construction company)	16 (12)
6	Property Development Manager	5 (3)
7	Senior Project Manager	28 (16)

Table 4: Process of fabricating causal links from interview data

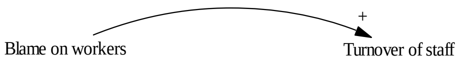
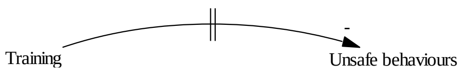
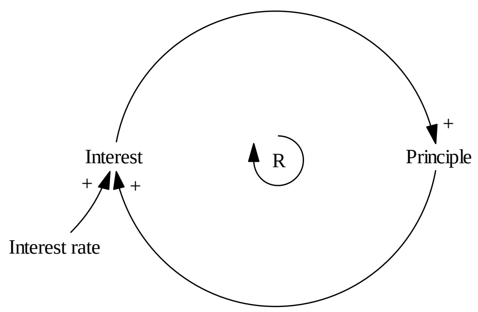
Quote	Cause	Effect	+/-	Causal Links
"The contactor, they always blame the workers."	Accidents	Blame on workers	+	
"After an accident, the workers, they get canned straight away. The companies do that, the blame gets unfairly put on the workers."	Blame on workers	Turnover of staff	+	
"High turnover definitely has an effect on a contractor's willingness to train. Without a doubt. It's money down the drain."	Turnover of staff	Training	-	
"Training people to do the job means that they will do the job more safely and more quickly"	Training	Unsafe behaviours	-	

Table 5: The nodes and safety themes that the safety archetypes are composed of

Safety Archetype (A)	Safety Theme (S)	Nodes (N)
Effects of a migrant workforce (A1)	Foreign workers (S1)	Use of foreign workers (N1) Illegal workforce (N2) Communication issues (N3)
	Inadequate workforce (S2)	Uneducated workforce (N4) Lack of training (N5) Poorly paid workforce (N6) Unskilled workforce (N7) Inexperienced workforce (N8) Undisciplined behaviour (N9)
	Construction industry factors (S3)	Workers' top priority is income (N10) Subcontractor driven market (N11) Site factors (N12)
Corporate accountability and profit driven business culture (A2)	Emphasis on health and safety (S4)	Health and safety is not a priority (N13) Lack of safety culture (N14) Life is cheap (N15) Health and safety is simply 'box ticking' (N16)
	Organisational practices/views on health and safety (S5)	Poor accepted practices (N17) Reactive organisational culture (N18) Lack of training (N19) Desire to avoid regulation (N20) Lack of risk awareness by management (N21) Poor construction equipment (N22)
	Lack of caring culture (S6)	(Client/contractor) Drive for profit (N23) No regard for foreign workers (N24) Life is cheap (N15) Cultural factors (N25) Accountability of client/contractor (N26) Blame on workers (N27)
Issues in the regulatory system (A3)	Legislation and enforcement issues (S7)	Poor enforcement of regulation (N28) Lack of budget for health and safety authorities (N29)

		Poor legislation (N30) No desire to change legislation (N31)
	Poor governmental leadership (S8)	Corruption (N32) Reactive decisions (N33)



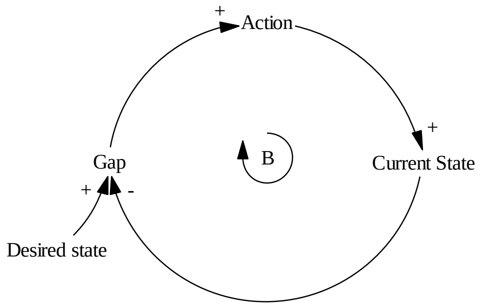


Figure 1a: Example reinforcing loop **Figure 1b: Example balancing loop**

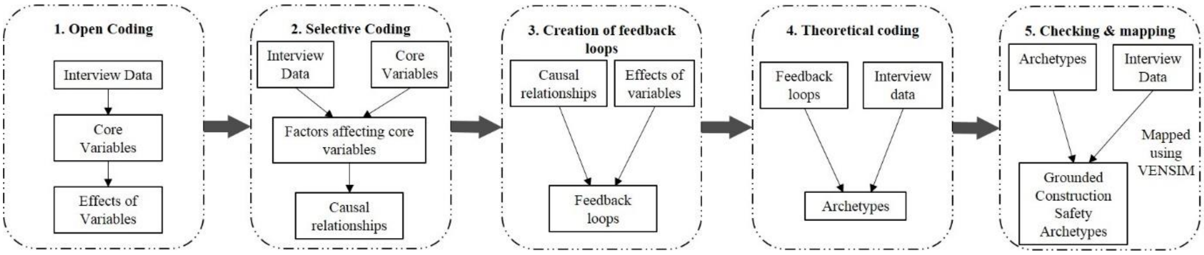


Figure 2: Process of data analysis (adapted from (Burchill & Kim, 1993; Guo et al., 2015)**)**

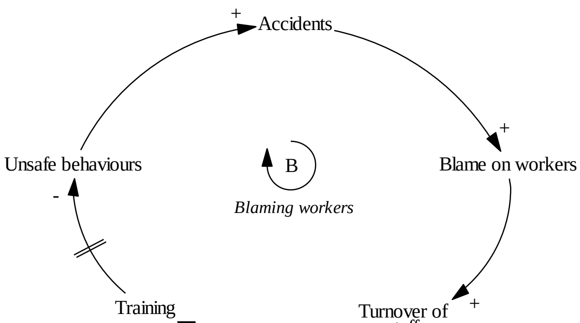


Figure 3: Amalgamation of causal links into a causal loop diagram

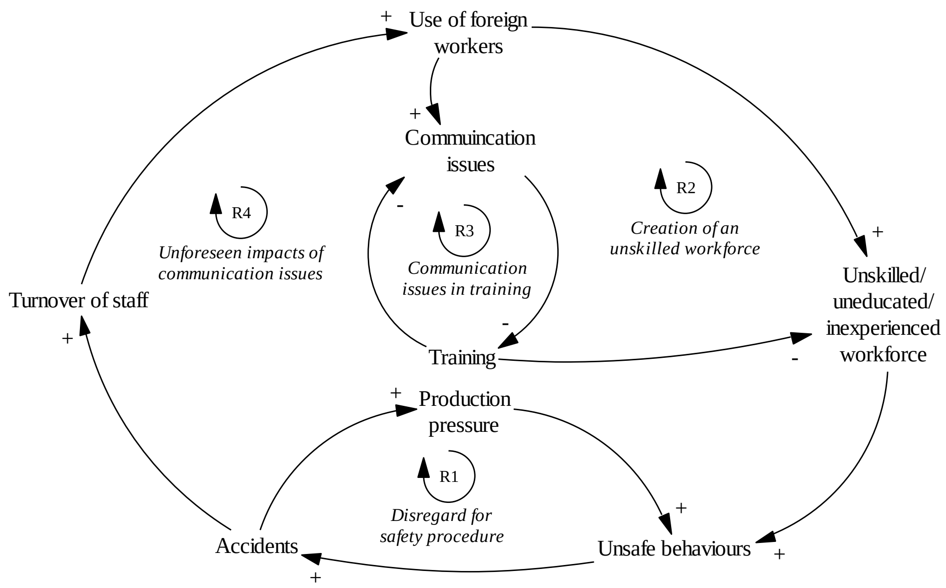


Figure 4: 'Effects of a migrant workforce' archetype

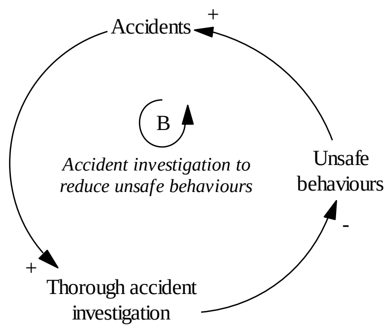


Figure 5: 'Accident investigation to reduce unsafe behaviours' balancing loop

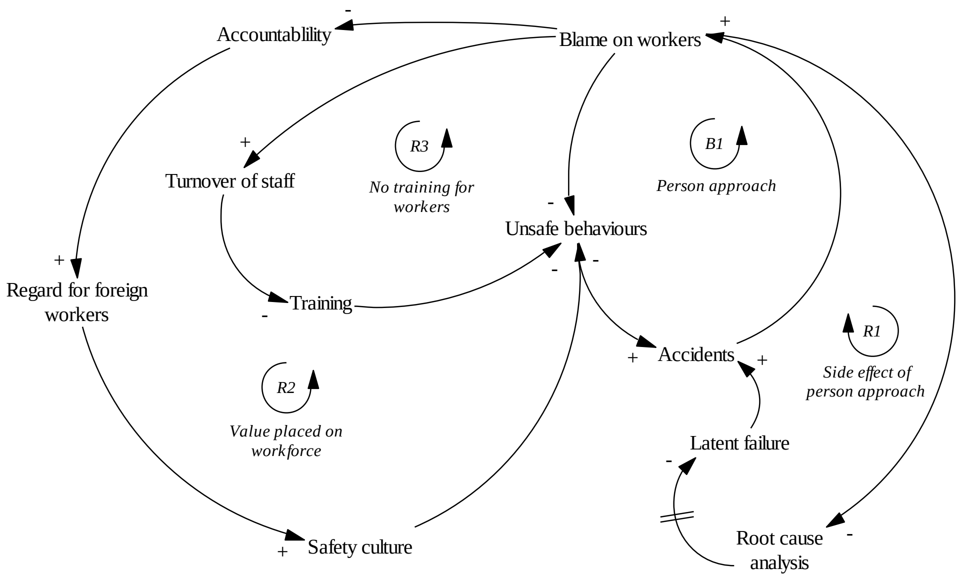


Figure 6: ‘Corporate accountability and profit driven business culture’ archetype

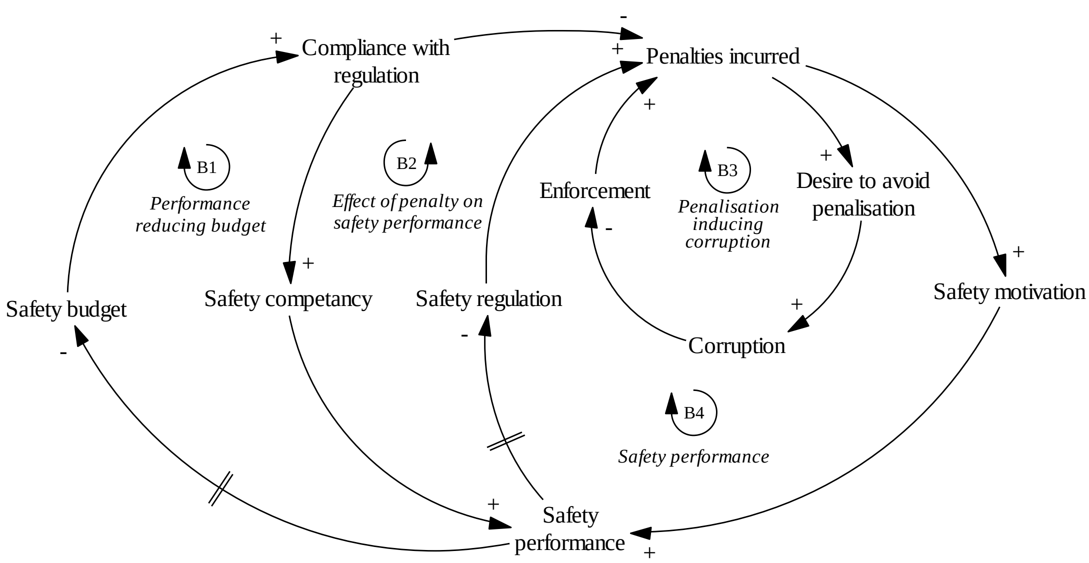


Figure 7: ‘Issues in the regulatory system’ archetype